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Memorandum M-1470

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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, MassachusettsSUBJECT: GROUP 61 BI-WEEKLY, April 25, 19521.0 GENERAL

(C. R. Wieser)

General McCauley, Commanding General of the 32nd Air Division has written to express his support of experiments with the Ground Observer Corps. Lt. Colonel Merle Drury, who is stationed in Boston, will introduce us to the personnel at the Manchester Filter Center.

Project Lincoln is forming a committee to investigate the project's requirements for ground-to-air data transmission. I will represent Group 61, and any ideas on data-link requirements should be directed to me as early as possible.

A discussion was held to review the objectives of Linvill's analysis section. We agreed that they will do the following:

1. Continue work on smoothing
2. Start work on analysis of the dynamics of interceptor control
3. Look for ways in which the above two jobs are interrelated.

2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

TERMINAL EQUIPMENT PLANNING

An analysis of the engineering manpower requirements for circuit design and testing work on the terminal equipment system covering the remainder of this year has been made. It appears that the present staff plus those hired but not yet joined can accomplish the minimum job outlined in the summary schedule finished two weeks ago. Some additional manpower will be needed if other work is to be undertaken within this period. At the present time there is not sufficient information to make meaningful estimates for the year 1953.

So that installation work will not become a bottleneck, Newitt has started preparation of specifications for the air conditioning system for Room 156. He will follow up on this until there is an

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2.0 ENGINEERING EQUIPMENT (Continued)

(E. S. Rich) (Continued)

engineer in Chan Watt's installation group to take over.

A discussion was held with P. Rosen of Division 2 on what they will provide in the SDV Discriminator which feeds pulses to the phone line counters. A satisfactory decision was reached, one which results in a minimum of circuitry on their panel and approximately four additional standard plug-in units in our racks for each phone line.

The one remaining unknown before a final block diagram of the phone line equipment can be prepared is the question of how the clutter rejection CRT will be integrated. One of the factors that may influence this block diagram is how much resolution is required in the mapper. If high resolution is needed one might like to use a-c coupled amplifiers for scope deflection so that we would need to supply decoder outputs that were chopped in some fashion. Preliminary studies of raw SDV data are being made to get more insight into the ingredients of this problem.

(J. H. Newitt)

The past bi-weekly period has been spent in the study of WWI power supply equipment in preparation to actively participating in the engineering work connected with the installation of the rack equipment for the buffer drum, auxiliary drum and telephone line terminal equipment. The last few days of the subject period have been devoted to accumulating data on the WWI air conditioning equipment and setting up air conditioning requirements for the drum equipment to be located in Room 156. Preliminary recommendations have just been completed and representatives from air conditioning firms will be called in in the very near future so that a final specification can be prepared for bidding purposes.

The simplified and detailed description of the telephone line equipment, buffer drum equipment together with a general description and outline of all units of the MULDER system has been typed and is available for criticism and indoctrination use. This document will be kept up-to-date and expanded as time permits during the progress of the project.

(A. V. Shortell)

The Bedford MEW terminal equipment is in the process of being moved to eight-foot racks.

Some attention has been given to the voice channel multiplex equipment used with the Magnecorder. Approximately half of the vacuum tubes used in this equipment have been replaced because of low plate current and top shorts. This replacement has resulted in somewhat improved operation but further refinements seem necessary. Better filtering in the demodulator would remove the background noise due to the 8KC carrier and the low frequency carriers used in the data transmission. Further work will be done on this equipment during the next bi-weekly period.

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2.0 EQUIPMENT ENGINEERING (Continued)
(H. J. Kirshner)

Some difficulty was encountered with Rockport terminal equipment during this period. The source of the difficulty was found to be a combination of a faulty flip flop panel and a faulty delay panel.

The twin track Ampex S-3102 recorder was delivered but has not been placed in operation because of an excessively noisy playback amplifier in one channel. Unless the source of the noise can be found rapidly, this amplifier will be returned to the vendor for replacement or repair.

MEW terminal equipment has been moved and is now in operation.

3.0 BEDFORD EXPERIMENTS
(D. R. Israel)

On April 17 and 18 a trip was made to the 762nd AC&W Squadron at North Truro. This trip provided a good deal of prospective for understanding present problems in radar detection, height finding, and fighter direction.

The following topics are presently under study or under programming by members of the group:

- a) tracking of high-speed aircraft
- b) utilizing beacon returns
- c) conduction of interception with maneuvering targets and high-speed interceptors
- d) a program for ordering a height finder at Rockport for use in connection with an interception program
- e) use of new interception methods
- f) the development of a multiple aircraft tracking program for use with the MEW radar and with sufficient track capacity to permit us to use automatic initiation techniques for interceptions, permit us to accumulate track information for correlation with GOC reports, and to permit us to attempt flight-plan correlation.
- g) experimentation with final phase guidance.

All work on experimental evaluation and development of smoothing techniques has been discontinued. NLS-2C appears to be the best and the simplest of the methods studied.

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3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket)

FLIGHT TESTS

Only one flight test was scheduled the past bi-weekly period, this test being cancelled because of computer unavailability. A 2 a/c interception using a maneuvering target with a pre-determined flight plan was to be attempted. This will be tried at a later date.

(P. O. Cioffi)

The task of writing up the two methods of computing an interception heading angle in subprogram form is still underway. So far, the subprogram for the lead angle solution method has been completed.

An already existing program (Omni-Display T314-7) which tracks two aircraft has been modified to include the lead angle solution method for computing an interception heading angle and a decimal scope display of the aircraft separation, pursuit and collision heading angles. I plan to run this program using various Magnecorder Tapes in an effort to determine the value of this particular interception computation in an operational status.

(C. Gaudette)

An outline of the talk on smoothing which was given to the most recent indoctrination group has been prepared. A memorandum entitled "Smoothing methods Developed for the Bedford Experiment" will be written using the outline as a foundation. The memo will include a discussion of the results obtained in the numerous smoothing analyses.

(C. Zraket)

The Final Approach Guidance Program has been checked out after a number of tape duplication errors had been corrected. It is hoped that this program can be tried operationally in the near future.

F. Heart and myself are undertaking a series of tests to determine what is required to successfully track a jet aircraft (F-94) so that a jet interception can be attempted in the future. Initially, we will use Magnecorder #133, which contains several runs using an F-94, in conjunction with DPO and the Final Approach Guidance Program, both of which employ NLS-2c.

Some time during the past bi-weekly period was spent processing IBM cards for the GOC group. This work was carried out at the Statistical Laboratory at MIT.

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3.0 BEDFORD EXPERIMENTS (Continued)

(Frank Heart)

A program to test Beacon Response was tried for the first time, but is not yet operating correctly.

Additional time was spent testing various modifications to the basic two aircraft interception display program. Unfortunately, it was not possible to get enough trouble-free computer time to check out certain troubles. The modification which displays range and azimuth from Rockport (for height-finder use) appears to work correctly. However, it depends upon the main program, and the main program has been subject to certain as yet inexplicable troubles. In particular, a version of the program which operated correctly several times gave strange results when tried recently. It is hoped that this trouble will be located soon. It is becoming more and more obvious that this program should be completely rewritten, if it is going to be in use very much longer.

In order to allow C. Zraket to resume use of a Guidance-Punching program, an old Single Aircraft Printing Analysis program was taken out of moth-balls and tried. Somewhat surprisingly, it operated correctly.

Recently, several Magnecorder recordings were taken of F94 tracks, at various altitudes; preliminary to attempting to use the computer to track these aircraft, these recordings were visually studied. For the particular recordings taken, the 8000 ft. altitude appeared better than 10,000 ft. altitude. Due to lack of computer time these recordings have not yet been processed, but the coverage was sufficiently good to predict that tracking will not present too many difficulties.

(S. Knapp)

A Multiple Aircraft Tracking Program has been written and operated successfully. The program tracks ten aircraft no five of which are in the same search sector. The program should handle up to ten in the same search sector, and this will be tested in the near future.

Some work has been done on the Four Aircraft Interception Program. I plan to use a direct method for the heading angle, similar to the method used in the Three Aircraft Interception Program.

4.0 DATA SCREENING

(R. L. Walquist)

In conjunction with Ed Rich, some photographs were taken of the ground clutter from the Rockport radar in order to obtain some idea of the problems associated with removing this clutter by means of "video mapping" techniques. Pictures were taken under the following conditions:

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4.0 DATA SCREENING (Continued)

(R. L. Walquist) (Continued)

1. Clear day, antenna elevation of 80 mils.
2. Overcast at 11,000 ft., light rain, antenna elevation of 80 mils.
3. Moderate to heavy rain, antenna elevations of 80, 120, and 160 mils.

These photographs were taken primarily to determine how consistent the ground clutter is and to what extent rain and clouds affect the clutter picture. Ed Rich has mounted these photographs and has them available for interested persons.

(W. S. Attridge, Jr.)

I have finished a detailed flow diagram of the smooth and predict section of Muldar Tracking Program #1. The programming of this section is now being completed.

(P. R. Bagley)

FILTERED DATA RECORDING

Data Recording for Three Radars (T-909) has been revised with the help of J. Ishihara, and has been sent to the tape room.

CLUTTER REJECTION

Two new techniques were tried out with the Stationary Clutter Rejection Program (T-716). Entirely discarding all data from the Mt. Monadnock region resulted in a medium-sized improvement. Using a week criterion for accepting clutter data and "verifying" the clutter table resulted in no spectacular improvement. Photographs were made of the displays in both cases. I feel that a satisfactory solution to the clutter rejection problem will require more cogitation and experimenting.

(J. Ishihara)

Work continues on the correlation section of the MULRAR Tracking Program in collaboration with W. Attridge and P. Bagley. Some further ideas and suggestions of members of the group have yet to be investigated.

5.0 TRACKING AND CONTROL

(M. Frazier)

The PWTF for the Bedford-Rockport data has been written and will be checked out as soon as data tapes for it can be prepared. The

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5.0 TRACKING AND CONTROL (Continued)

(M. Frazier) (Continued)

present Bedford-Rockport tracking programs, when run with clutter from the Rockport radar present as well as Magnecord data, have improved in their operation in some ways, but deteriorated in others, and a search is being conducted for the faults leading to these difficulties. Polysmooth has been plagued by tape preparation errors in the last two weeks, and little concrete progress has been made in bringing it to operating status.

In considering the problem of tracking more than one aircraft with more than one radar without buffer storage, a process which may be described as "semi-real-time" programming is worth investigation. This consists of running the program in a given quarter-second interval as a non-real time problem, and every four hundred orders going into a closed subroutine which inspects all input flipflops and stores any data present for the next quarter-second's processing. If the system is absolutely saturated in a given quarter-second interval a total of about 560 orders are available for processing each piece of data, (where n is the number of radars giving continuous data). Further processing would be done when time was available, probably on a priority basis. A suggested order of priority in processing data is:

Correlation (preliminary: r, θ)

Display and final correlation (x, y)

Smoothing

Interception, Transfer of Tracks to other radars, and other ancillary computations.

This order of priority is based on having the least possible amount of data to carry over for later computation in temporary storage if overloading occurs. It is felt at the moment that the amount of computation with this system is more likely to be storage-, rather than time-, limited.

(A. Mathiasen)

Tests of TRASACT I & II with varied parameters α and a have shown about equally good results for all values used. α ranged from $1/16$ to $1/4$ and a varied accordingly.

The second week was spent on vacation.

(W. Lone)

The TRASACT FF (2 radar single aircraft tracking, first fit) program has operated successfully. The extrapolation of position with

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5.0 TRACKING AND CONTROL (Continued)

(W. Lone) (Continued)

respect to one radar when the aircraft was out of range of this radar based on the low velocity prediction for the first ten scans resulted in a large deviation between the observed and predicted positions. This in turn caused too great a fluctuation in velocity when velocity was predicted from a radar which hadn't been a first fit the 14-second interval (hence not used) for a number of scans.

A program has been written, but is in need of correction, which uses the first return in 14 seconds to predict velocity and position, correlation with the other radar ceasing immediately for the 14-second interval upon receipt of a "better fit".

6.0 AIR DEFENSE CENTER OPERATIONS

(D. R. Israel)

On Tuesday, April 15, Fitz Quarrier of the Bell Telephone Laboratories and the CADS Committee, and Messrs. Tiffany and Harrison of the Willow Run Research Center visited the Laboratory to discuss work in connection with the GOC.

We have received some 2300 IBM cards from the Willow Run Research Center, these cards containing observer report information for the December 1, 1951 exercise at White Plains. With the help of Charles Zraket and with the cooperation of Frank Verzuh, Director of Statistical Services at MIT, we have processed these cards on IBM machines and have prepared cards and printed sheets for processing the data. This work has already been started on the plotting board in Rm. 157 where we are plotting and filtering those reports on multi-engine aircraft.

Elements of the GOC tracking program are being developed. During this past bi-weekly period we have done a large amount of work in connection with the "scoring" of reports. This "scoring" is one of the methods to be used in associating reports belonging to the same aircraft track. The results up to the present time have been very successful and seem to indicate that the initial values in our "scoring" tables are quite satisfactory.

(C. Gaudette)

The GOC (Ground Observer Corps) Data Display Program has been written. Operation has been delayed by tape preparation errors.

We now have the observer reports received at the White Plains Filter Center during one of the test exercises on IBM cards. It may be possible to transfer this information directly to paper tape in a form that can be used by WWI. Investigation of the method is in progress.

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6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(F. A. Webster)

Plotting and analysis of ground observer data has been continued. Some consideration has also been given to the conditional relations of time, heading and type of aircraft from the point of view of developing a program that can properly weight these factors in the establishment of tracks.

The program written for the indoctrination problem during this period will need further squeezing.

A talk was given at RLE on auditory mechanisms used in the detection of signals against critically interfering noise.

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7.0 ASSOCIATED STUDIES

(P.R. Bagley)

MAGNETIC TAPE SUBROUTINES

The magnetic tape block recording and reading subroutines (T 988-4 and T 989-1) have been revised and rerun successfully. They are being written up for inclusion in the Subroutine Library.

INDOCTRINATION PROBLEM

My indoctrination problem, a Single-Aircraft Tracking Program, has been checked out and approved by W. Attridge.

DATA PRESENTATION

An interoffice memorandum suggesting ways of presenting Muldar tracking and interception information to human operators has been prepared for R. Walquist. I plan to pursue the subject further.

(H.R.J. Grosch)

There have been many meetings of the WWII and WWII Block Diagram groups. I issued a memorandum (M-1464) calling for a multiplication speed of 16 μ s and a "red tape" speed of 8 μ s. I also proposed an instantaneous shift (right or left), clear, and complement array of n cores for a n -bit word.

(F. Heart)

A large part of my time has been spent writing a Master's Thesis, entitled "Applications of Self-Checking and Self-Correcting Codes to Digital Computers."

A small amount of time has been spent assisting in the current indoctrination efforts.

(R.L. Walquist)

Two days of this bi-weekly period were spent on a trip to Truro to study their AC&W installation. It appeared that two of their biggest problems are identification and initial pickup of aircraft. Initial pickup was complicated primarily because of large amounts of ground clutter and marginal returns from ships at sea. M.T.I. is available but has not proved too satisfactory for them. Traffic-handling capacity was limited. Dead-reckoning had to be carried out on several aircraft flying through the worst part of the ground clutter. Identity of close aircraft (10-20 mile separation) was sometimes confused by the plotters working on the display board. It appears that any aid such an installation could get from automatic equipment would be very helpful.

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7.0 ASSOCIATED STUDIES (Continued)

(R.L. Walquist) (Continued)

Some time has been spent in studying the effect of the Air Defense problem on the design of WWII. Some of my impressions were presented at the WWII meeting of April 11, 1952.

Two discussions were held with D. Hogan who is visiting D. Buck and has been working on the 1101 computer. Several interesting points were brought out on their use of magnetic drums and their forced-programming of the computer. Some of their ideas are worth noting for the WWII group and will be written up shortly as an M-note.

8.0 COMPUTER OPERATIONS

(C. Gaudette)

Data Screening.....	1.25 hrs.
Tracking and Smoothing.....	22.25 "
Aircraft Control.....	8.09 "
Miscellaneous.....	2.33 "
Total Analysis.....	33.92 hrs.
Calibration.....	1.25 "
Total Time Used.....	35.17 hrs.
Lost Time.....	13.50 "
To Math Group.....	4.33 "
Total Assigned Time.....	53.00 hrs.

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9.0 PUBLICATIONS

(M.R. Susskind)

The following material has been received in the Library, Rm. 217, and is available to Laboratory personnel:

LABORATORY REPORTS

1. "WWII Block Diagrams Meeting of April 10, 1952," Hosier, W.A., M-1457, pp.1-2.
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2. "Whirlwind II Meeting of April 11, 1952," Taylor, N.H., Mayer, R.P., M-1461, April 21, 1952, pp.1-6.
CONFIDENTIAL
3. "Predicted Operating Statistics for WWII," Grosch, H.R.J., M-1464, pp.1-2.
CONFIDENTIAL

TECHNICAL REPORTS

1. "Technical Data Digest," Armed Services Technical Information Agency, Document Service Center, U.B. Building, Dayton 2, Ohio, April, 1952, Lib. No. 1690.
RESTRICTED
2. "Radar Homing Set," Summary of Flight Tests, Report ZM-430, Convair, AN/APN-58, submitted under US Navy Contract No. NOa(s)8817, February 1, 1952, Lib. No. 1777.
CONFIDENTIAL
3. "Field Tests of Spruce Ranging Equipment," Whitney, T.R., Lawrence, W.N., Mapes, J.M., Research Department, U.S. Naval Ordnance Test Station, Inyokern, China Lake, California, October 18, 1951, Lib. No. 1778.
CONFIDENTIAL
4. "Revision of Hermes A-1 Stabilization and Flight Path Control System Report TR55277," Special Projects Engineering Divisions, Aeronautics and Ordnance Systems Engineering Divisions, Apparatus Department, General Electric, Schenectady, New York, February, 1952, Lib. No. 1779.
CONFIDENTIAL
5. "Rocket Research Report No. X, The Viking 7 Firings," Rosen, M.W., Bridger, J.M., Jones, A.E., Rocket Sonde Research Branch, Radio Division I, Naval Research Laboratory, Washington, D.C., Lib. No. 1781.
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